



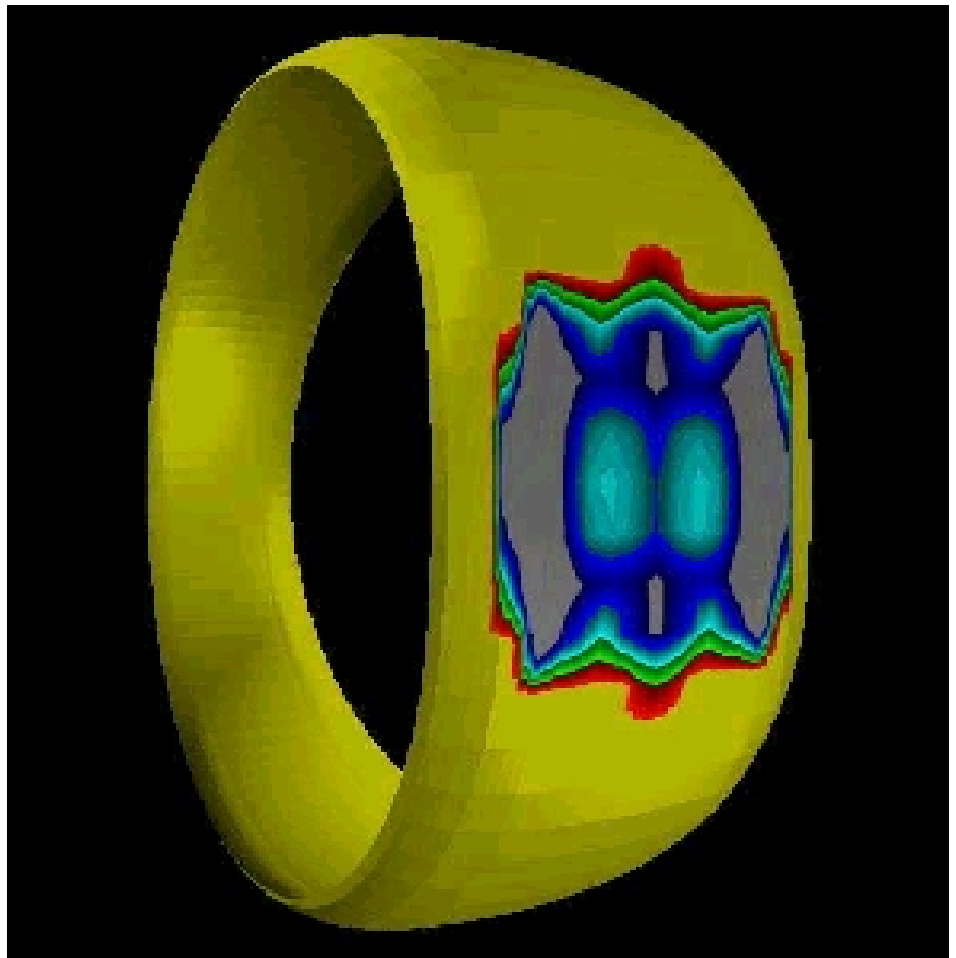
GOODYEAR AND SANDIA WORK TO REPLACE CONVENTIONAL DESIGN METHODS WITH SIMULATIONS

COLLABORATION PRODUCED RELIABLE SIMULATION TOOL
TO REPLACE BUILD-AND-TEST METHOD

A common bond in classical mechanics has created a teaming effort between Goodyear and Sandia to replace the conventional build-and-test design method with a reliable simulation tool. The collaboration has provided Goodyear with a modeling tool that promises to shorten production time and reduce costs. At the same time, Sandia's DOE Defense Programs has also been able to take advantage of the new features to do simulations that are an asset in the production of neutron generators.

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A complex simulation of tire performance produces a "footprint" of information similar to results from an actual prototype test. The high-fidelity computer design and manufacturing tool was developed by Sandia National Laboratories in partnership with The Goodyear Tire & Rubber Company. Designers at Goodyear will be able to run the simulation in place of the build-and-test method of tire design, which is both costly and time consuming. **Sandia has used the improved simulation tool to reduce portions of a neutron generator cure schedule by a factor of two.**



Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.



If you are pondering the security of our nation's weapons stockpile, you may be reassured by the sight of a rolling tire. A joint effort by Sandia National Laboratories and The Goodyear Tire & Rubber Company to simulate tire performance has not only provided Goodyear with improved design capabilities but has also enhanced Sandia's production of neutron generators, critical components of nuclear weapons.

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Tires and neutron generators? “What we have in common is classical mechanics,” says Loren Miller, Director of Tire Performance Modeling at Goodyear. “Until we started to talk with each other, we didn't really recognize that we shared this area of technology. But in our work together, the labs, the government, and private industry have really benefited.”

The issue that first brought Goodyear to Sandia in 1993 was how to model the mechanical response of tires. Tires are complex structures, made of steel and rubber, and therefore stiff and flexible at the same time. Modeling their performance was extremely difficult, slow, and of limited fidelity.

“For Goodyear, the problem was rubber. For Sandia, it was manufacturing issues for weapons components, especially epoxies used to encapsulate the components,” says Hal Morgan, manager of Sandia's Engineering and Manufacturing Mechanics Department. His group, tasked with the computational mechanics simulations of nuclear weapons systems and components, had developed finite-element technology that they believed might help Goodyear's problem.

Skeptical at First

Skeptical at first, Goodyear's modelers were soon impressed by Sandia's ability to deliver a simulation tool that helped them respond better to their customers. Sandia's efforts not only increased the fidelity of Goodyear's models, thus providing more accurate results for Goodyear, but also significantly reduced computational time.

And a better mechanics tool for Goodyear meant that Sandia could use those same features. “When we first talked about the project, we had a code that we thought was adequate for most of the defense work we were doing,” said Morgan.

“But we knew it needed new features for the Goodyear work. And during that work, we found that the new features improved the accuracy of our Defense Programs simulations and enabled us to do others that were not possible previously,” said Morgan. “For example, more accurate encapsulation simulations were used at Sandia to reduce portions of a neutron generator cure schedule by a factor of two.”

Since the initial effort, Goodyear has expanded the original CRADA to include an effort to embed complex simulations as an integral part of its design process. The idea is for complex simulations to replace the build-and-test method of tire design, which is both costly and time consuming. With the conventional process, a

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tire designer selects a tread and a tire “carcass” (everything but the tread), puts them together, requests a prototype, tests the prototype, and then alters the design based on the results. Then he or she repeats the process.

Now Goodyear was asking Sandia to build a computational infrastructure around the finite-element code so that designers could quickly generate models and evaluate proposed designs computationally—with the same level of confidence as they had in the prototype tests.

Production Tool

“When Goodyear asked us about this project, our codes were research codes, meaning that only experienced modelers and developers could coax solutions out of them,” Morgan said. “Our modelers were used to tolerating a high degree of frustration. Now Goodyear was asking Sandia to take the code to the next step, making a real production tool that designers could use.”

Technical advances during the creation of this computational frame work, which will be delivered this fall, include building automatic mesh generation for tires. In a finite-element process, the geometry, often represented by a solid model, must first be discretized or meshed. A grid or mesh divides the geometry into computational cells over which the numerical solution is computed. It is not unusual for time spent in mesh generation to be significantly larger than actual calculation time.

“The Holy Grail of finite-element model creation is to have an automatic mesh generator,” said Morgan.

In developing this simulation capability for Goodyear, Sandia has learned valuable lessons about how to create a similar environment that will enable complex simulations to become more available to Sandia designers.

Tangible Benefits

“Through this work we’ve discovered many tangible benefits. For example, we’ve learned that when you’re automatically generating a mesh, the integrity of the solid model from which it is created is important,” said Morgan. “We’ve uncovered issues and rules for how solid models must be created so that they can be automatically meshed. We have also improved our mesh generation tools. Moreover, we’ve learned what it means to use complex simulations in an industrial design environment,” Morgan said. “When we see how private industry uses complex simulations to improve design and production, that helps us do our business better.”

Continued successes have strengthened the Sandia-Goodyear relationship, leading to additional research projects that will benefit both. Currently, Sandia is examining material durability, particularly aging, and also extending the simulation tool to study both system-wide and local effects simultaneously.

—J. Chapman

It’s the people

What’s the best part of teaming with the labs? “It’s the people,” says Loren Miller, Director of Tire Performance Modeling at Goodyear. “Sandians are exceptionally talented,” he said. “The real benefit to working with the labs is access to people of this high caliber.”

Miller believes that Goodyear and Sandia have forged a particularly successful relationship because of some similarities. “We both have to build products that work, reliability is very important, and everyone takes their work seriously.”

The blending of two perspectives has also been a significant component of the teaming success. “We’re really pushing the state of the art in the area of high fidelity computer design and manufacturing simulation,” said Miller. “In this kind of situation, there are two key people, and they are the Sandia and Goodyear scientists or engineers that have to work together.

“Everyone I know who has worked with Sandia—and I’m talking about some pretty skeptical engineers and scientists—has enjoyed the challenge and the interaction. I really believe that it’s on the personal level that the working relationship between Goodyear and Sandia has become so successful.”

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